<Session 4: Biomedical Application>Ultrasound Doppler Fetal Heart Valve Signals Telemetry for Patient-Conducted Remote Fetal Monitoring Using Blue-Tooth Local Connection to Networked PDA

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Ultrasound Doppler Fetal Heart Valve Signals Telemetry for Patient-Conducted Remote Fetal Monitoring Using Blue-Tooth Local Connection to Networked PDA

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Abstract

For Patient-Conducted Remote Fetal Monitoring an ultrasound Doppler sensor-telemeter device is developed. It selectively receives fetal heart valve signal in Doppler domain, for best accuracy of beat-to-beat cardiogram. Using a blue-tooth system the signal is linked to patient owned PDA such as smart phone, for local signal processing as well as networked resources for diagnosis and archive.

Keywords: Doppler, fetal, valve, cardiotocograph, PDA, smart-phone, ISM-band ont size

Background of the study

The established standard method of fetal monitoring, including for out-of-hospital patient conducted practice, is wide-beam ultrasound Doppler system followed by adaptive correlation ratemeter (1). Although its continuous capture success rate for mildly traveling signal source such as fetal heart during is high and reliable, an unspoken issue in the wide-beam system used to date is its signal quality for heart rate measurement being always suboptimal due to the system capturing the fetal heart moving tissue as whole to cause a slightly blurred correlation peak when processed for heart rate measurement.

Problem and Proposed Solution

The known best timing signal is spiky valve motion signal available when selectively filtered for 0.25-0.5 per mill Doppler-shift. We devised such system including Blue-Tooth or 433MHz ISM band telemetry transmitter from patient abdomen to cardiotocograph mainframe or PDA such as smart-phone for signal processing.

Materials and Methods

The design of our patient wearable prototype Doppler sensor-transmitter is focused on patient conducted, home or outdoor or work-environment fetal monitoring in terms of NST (non-stress test). The size is 60mm dia 35mm high, weights 61g including all the necessary electronics and battery. Ultrasound frequency is 2MHz, while aerial frequency is either 2.4HGz (for blue tooth) or 433MHz (for ISM band SCPC system). 25mm dia. semilunar ultrasound transducer pair is built in with diverging acoustic lens to have medium width beam cross-section. For Doppler receiver a straight autodyne receiver having no RF amplifier is adopted for minimum power drain (2). It has a valve signal filter at early stage of Doppler processing chain. Single 3 volt CR2 lithium battery powers all the electronics, battery drain is less than 10mA to run for more than 3 days continuously.

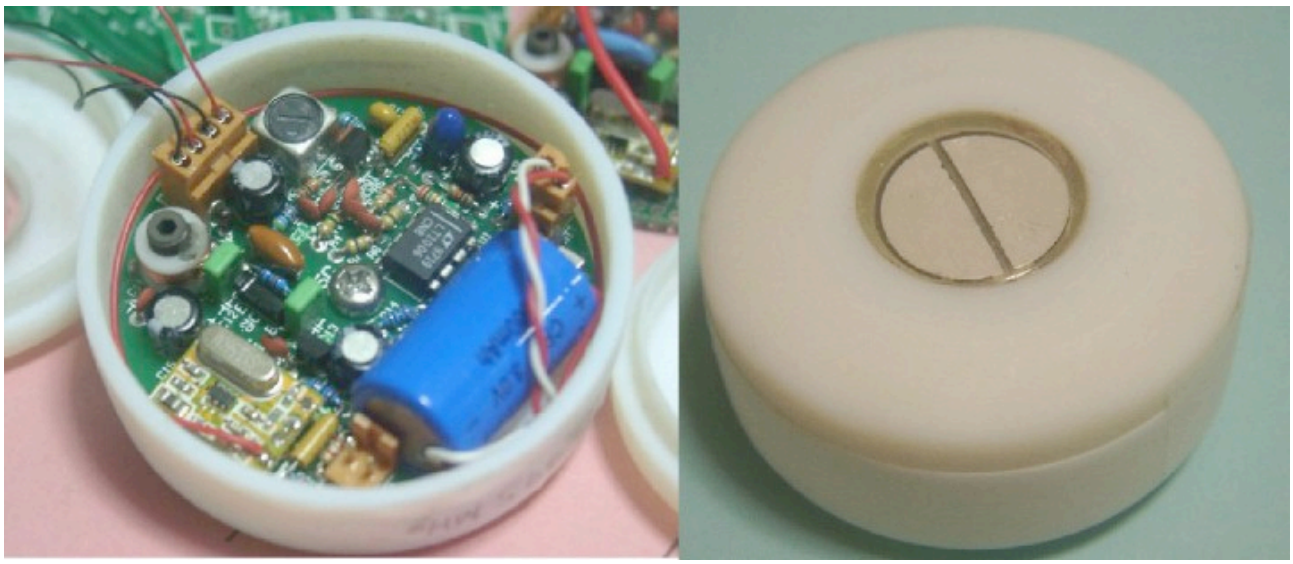

Fig.1

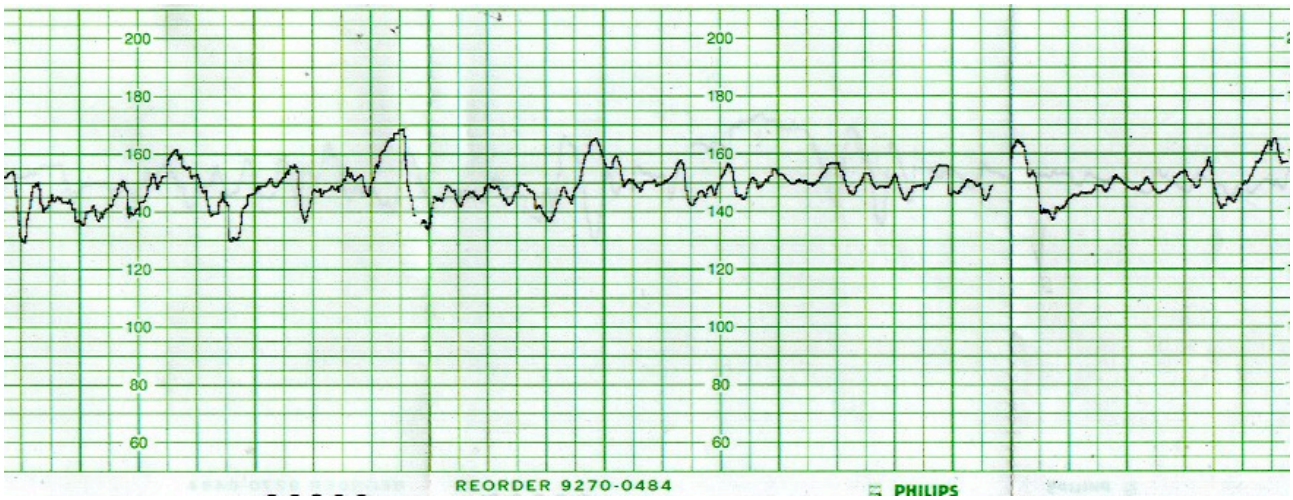

Fig.2

Results & Discussion

Fig.1 shows its looks, while fig.2 shows an example of cardiogram of near term gravidae taken by this device by herself, with receiver station used is an external audio input mode of hp8041A fetal monitor (cardiotocograph). Such fully diagnostic quality cardiograms are consistently obtained. Design integration with external labor sensor and time coded ID generator for post-reception signal archive with time axis alignment is also underway.

Conclusions

We successfully devised a Doppler-telemeter unit for patient conducted non-stress test fetal monitoring, with blue-tooth or ISM band SCPC connection. It will extends the monitoring to her indoor and outdoor environment using her own PDA (smart-phone) for local signal processing and network connection to host system.

References

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